PLANTING DATE:
A Means of Limiting Exposure To Heat Stress

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UA RECOMMENDATION:
- Spring Soil & Weather Conditions
- Minimize Exposure To Heat Stress
- Earlier Termination & Harvest

Early Optimal Planting Dates
PLANTING DECISIONS

• Soil Temperature
• Weather Forecast
• Summer Heat Stress
• Variety

SOIL TEMPERATURE ISSUES

• Cool Soils
  – Slow Germination
  – Increased Susceptibility To Disease

• Cold Soils
  – Chill Injury
  – Root Damage/Seedling Death
  – Season Long Reduction In Performance
MINIMUM SOIL TEMPERATURES
Often Used In West To Guide Planting

- 65F+ : Optimal
  - 3-5 Days
- 60F : Acceptable
  - 5-7 Days
- 55F: Marginal
  - 7-10 Days
  - Reduced Stands
- 50F: Danger
  - 10+ Days
  - Poor Stands
  - Root Damage

Source: Model of Wanjura

WHY MINIMUM SOIL TEMPERATURE??

- Research Uses Average
  - Optimal: 75-85F
  - Acceptable: 68-75F
  - Danger: <65F
- Minimum & Average
  - Are Closely Related
- Minimum
  - Easier To Measure

8 am Soil Temperatures
FIRST DAY IS CRITICAL!!

As Soils Cool To 50°F...

- Cold Imbibition (First 6 Hrs)
  - Abortion Of Radical Tip
  - ? Afternoon Planting ?
- Cold Germination (18-30 Hrs)
  - Damage of Root Cortex
  - Premature Lateral Root Development
- Chill Below 58F
  - Delays Subsequent Growth

Source: Cotton Physiology Today, March 1990

IMPACT OF COLD (50F) SOIL

- Prior To Emergence
  - Poor Germination
  - Root Malformation
    - Loss of Tap Root
    - Cell Damage & Disease
- Post Emergence
  - Surface Rooting
    - Tap Root May Not Develop Properly
    - Poor Water Uptake
  - Water Stress
GOOD WEATHER FORECAST
Minimum Air & Soil Temperatures Are Closely Related

- Soils Reach...
  - Optimal Range
    - Lows in mid-50s
  - Acceptable Range
    - Lows in Upper 40s
  - Danger Range
    - Lows in Lower 40s

We Can Use Forecasted Minimum Air Temperatures As A Guide for Planting

GOOD PLANTING FORECAST
Soils Should Approach/Exceed Acceptable Thermal Range

- Clear Weather
  - Sun Helps Heat Soil
- Lows: 48F & Above
  - Minimum Soil Temps: Approach 60F
- Highs: 80F & Above
  - Warm Daytime Soils Accelerate Germination
- Heat Units
  - 10 HU/Day or 70 HU/Wk
  - 528 HU After January 1
  - April 3rd
### AZMET Hourly Weather Data: MARICOPA: Feb 23 2009

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### AZMET Daily Weather Data: MARICOPA: Feb 23 2009

- **Temperature**
  - Max: 84.0°F
  - Min: 49.6°F
  - Mean: 65.5°F
- **Humidity**
  - Relative: 74.8%
  - Dewpoint: 37.8°F
- **Dewpoint**
  - 37.8°F
- **Actual Vapor Press.**
  - 0.8 KPa
- **Vapor Press. Def.**
  - 1.5 KPa
- **Soil Temp. 4 in**
  - 67.8°F
- **Soil Temp. 20 in**
  - 67.1°F
- **Wind Speed**
  - 10.1 MPH
- **Solar Radiation**
  - 320.1 Langleys
- **Precipitation**
  - 0.00 Inches
- **Heat Units**
  - 86/55°F: 0.13 Inches
  - 86/50°F: 0.13 Inches
  - 86/45°F: 0.13 Inches

**Daily Summary Provides Minimum Air & Soil Temperature and Heat Units.**
WHY NOT JUST PLANT LATER?

- Yields Usually Suffer
  - Planting Date Studies
    - Work of Silvertooth
  - Heat Stress
    - Monsoon
    - Poor Fruit Retention

Source: Silvertooth et al., 2001

OPTIMAL PLANTING DATES

Compromise Between Two Competing Factors

- Proper Soil Thermal Conditions & Weather Forecast
- Minimize Exposure To Heat Stress
PLANTING DATE vs. MONSOON ARRIVAL

Prime Production Time Varies ~5 Weeks

COTTON HEAT STRESS

Develops When Mean Crop Temperatures Rise Above Stress Thresholds

- No Stress
  - Crop Temperature Below 82.4°F (28°C)
- Level 1
  - Crop Temperature: 82.4°F - 86°F (28°C - 30°C)
- Level 2
  - Crop Temperature: Greater Than 86°F (30°C)
FACTORS IMPACTING HEAT STRESS IN ARIZONA

Evaporation from plant leaves helps cool cotton canopies. This cooling effect is reduced during the monsoon, causing canopy temperatures to rise – often to stressful levels.

LEVEL 1 STRESS

Crop/Flower Temperatures: 82.5° - 86°F

• Reduced Fruit Retention
  – Losses: Low – Moderate
    • Young Bolls
    • 3-5 Days After Bloom

• Smaller Boll Size
  – Fewer Seeds/Boll
  – Increased Number of Motes
  – Shorter Boll Fill Period
LEVEL 2 STRESS

Crop/Flower Temperatures: > 86°F

- Heavy Fruit Loss
  - Starts Within 1-3 Days

- Damaged Squares
  - Malformed Flowers
  - 15 Days Later

- Reduced Boll Size
  - Hooked Beak Bolls

Fruit Retention of DPL 5415 Grown At Indicated Temperatures Through Primary Bloom Period

DISRUPTS NORMAL DEVELOPMENT OF REPRODUCTIVE STRUCTURES

Non-Stressed
Stamens Extend Above Stigma
Anthers Produce Pollen
Pollen Transfers to Stigma Easily

Stressed
“Stigmatic Exertion”
Caused By Short Filaments
Anthers Produce No Pollen
Ovules Often Not Receptive
HEAT DAMAGED FLOWER

“Elongated Stigma” Caused By Short Filaments

Results in Boll Abortion 3-5 Days Post Bloom

FOCUS ON PRIMARY BLOOM CYCLE

Generates Bulk of Yield in Most Years

Objective: Minimize Exposure to L2 Stress Before Peak Bloom
HEAT STRESS IS RELATED TO MONSOON INTENSITY

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The median data of occurrence for the more damaging Level 2 Stress is July 13th in central Arizona.

PININAL COUNTY

Arrival of Level 2 Heat Stress vs. Planting Date

Later Planting Exposes More of the Primary Bloom Period To Damaging Heat Stress
PLANTING WINDOWS

• FULL SEASON: 400-600 / 700 HU*
  • 19 March – 9 April / 17 April
• MEDIUM MATURITY: 400-800 HU*
  • 19 March – 25 April
• SHORT SEASON: 400-1000 HU*
  • 19 March – 8 May

* Heat Units After January 1st

HEAT STRESS & YIELDS

170 lb/a Difference Between Low & High Heat Stress Years
HEAT ISLAND HEAT STRESS

AZMET WEB PAGE
(http://ag.arizona.edu/azmet)

Click
WEEKLY COTTON ADVISORIES

Soil Temperatures, Planting Conditions, Heat Units, Water Use, Heat Stress, Normals & Weather Forecasts

HEAT STRESS ADVISORIES

Maricopa, Arizona
Cotton Heat Stress for 2008

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PLANTING SEASON FORECAST
March, April & May

Bias Toward Below Normal Precipitation

MONSOON SEASON FORECAST
July, August & September

Bias Toward Above Normal Temperatures
THE END

THANK YOU!